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No. 24—1911. (PART V.).

British Engineering Standards Association

(Incorporated 1918.)

FORMED IN 1901 AS THE ENGINEERING STANDARDS COMMITTEE

BY

THE INSTITUTION OF CIVIL ENGINEERS.
THE INSTITUTION OF MECHANICAL ENGINEERS.
THE INSTITUTION OF NAVAL ARCHITECTS.
THE IRON AND STEEL INSTITUTE.
THE INSTITUTION OF ELECTRICAL ENGINEERS.

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BRITISH STANDARD SPECIFICATIONS FOR RAILWAY ROLLING STOCK MATERIAL.

PART V.

COPPER PLATES, RODS AND TUBES, AND BRASS TUBES

(REVISED DECEMBER 1911.)

LONDON:

PUBLISHED FOR THE ASSOCIATION BY CROSBY LOCKWOOD & SON,
7, STATIONERS' HALL COURT, LUDGATE HILL, E.C. 4; AND 5, BROADWAY, LONDON, S.W. 1;
AND TO BE PURCHASED FROM ANY BOOKSELLER, OR DIRECT FROM THE OFFICES OF THE ASSOCIATION,
28, VICTORIA STREET, LONDON, S.W. 1.

November, 1918.

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PART VI. Steel Plates, Angles, etc., and Rivets for Locomotives, Carriages and Wagons.

BRITISH ENGINEERING STANDARDS ASSOCIATION.

MAIN COMMITTEE.

† SIR ARCHIBALD DENNY, BART. (*Chairman*).

SIR MAURICE FITZMAURICE, C.M.G. (*Vice-Chairman*).

SIR WILLIAM MATTHEWS, K.C.M.G. ...	Nominated by the Institution of Civil Engineers.
SIR DOUGLAS FOX	
MR. R. ELLIOTT-COOPER	
MR. ALEXANDER ROSS	
DR. W. C. UNWIN	
MR. H. A. IVATT	Nominated by the Institution of Mechanical Engineers.
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DR. WILLIAM H. MAW	
MR. G. AINSWORTH	Nominated by the Iron and Steel Institute.
DR. ARTHUR COOPER	
MR. ILLTYD WILLIAMS	
SIR THOMAS BELL, K.B.E.	Nominated by the Institution of Naval Architects.
SIR WILLIAM SMITH, C.B.	
COL. R. E. CROMPTON, C.B.	Nominated by the Institution of Electrical Engineers.
SIR JOHN SNELL	
MR. C. P. SPARKS	
MR. F. R. DAVENPORT	Co-opted by the Nominated Members to represent the Federation of British Industries.
MR. F. W. GILBERTSON	
HON. SIR CHARLES PARSONS, K.C.B. ...	Co-opted by the Nominated Members.
SIR ROBERT HADFIELD, BART.	
SIR RICHARD GLAZEBROOK, C.B.	

DR. J. H. T. TUDSBERY (*Hon. Secretary*).

MR. C. LE MAISTRE (*Secretary*).

MR. CHARLES DRESSER (*Assistant Secretary*).

† Succeeded the late SIR JOHN WOLFE BARRY, K.C.B., February, 1918.

BRITISH ENGINEERING STANDARDS ASSOCIATION.

The following are lists of the Members of the Sectional Committee on Locomotives and its Sub-Committees, and of the Sectional Committee on Railway Rolling Stock Underframes.

SECTIONAL COMMITTEE ON LOCOMOTIVES.

December, 1911.

Chairman, SIR DOUGLAS FOX.

War Office,* Major A. G. Stevenson, D.S.O., R.E.

India Office, Mr. A. Brereton, C.S.I.

Crown Agents for the Colonies: Mr. G. L. Eyles, C.M.G.; Mr. Ashton M. Heath.

Locomotive Manufacturers' Parliamentary Association: Mr. W. Lorimer (*North British Locomotive Co., Ltd.*); †Mr. Hugh Reid (*North British Locomotive Co., Ltd.*); **Mr. T. P. Reay (*Kitson & Co., Ltd.*).

Railway Companies' Association: Mr. J. A. F. Aspinall (*Lancashire and Yorkshire Railway*); Mr. J. F. McIntosh, M.V.O. (*Caledonian Railway*).

Association of Railway Locomotive Engineers: Mr. G. J. Churchward (*Great Western Railway*); ‡ Mr. G. H. Hughes (*Lancashire and Yorkshire Railway*).

Steel Ingot Makers' Association: § Mr. Maxmilian Mannaberg (*Frodingham Iron and Steel Co., Ltd.*).

Steel Founders' Association of Great Britain: Sir Robert Hadfield (*Hadfield's Steel Foundry Co., Ltd.*).

Mr. F. Wolley-Dod (*Chairman of the Calcutta Conference, 1901*).

**Sir John Wolfe Barry, K.C.B.; Mr. G. Ainsworth (*Consett Iron Co., Ltd.*); **Mr. H. C. Arbuthnott (*Taylor Bros. & Co., Ltd.*); Mr. J. Hartley Bibby (*John Bibby, Sons & Co.*); Mr. D. Cassels (*Steel Company of Scotland, Ltd.*); Mr. W. Collingwood (*Vulcan Foundry, Ltd.*); Mr. J. M. Dobson (*Hawkshaw & Dobson*); ‖ Mr. J. Duncan Elliot (*Carruthers & Elliot*); Mr. F. C. Fairholme (*Thomas Firth & Sons, Ltd.*); Mr. C. N. Goodall (*Robert Stephenson & Co., Ltd.*); Mr. E. Greg, Jnr. (*Nasmyth, Wilson & Co., Ltd.*); Mr. Cyril Hitchcock (*Sir George Bruce & White*); ¶ Mr. A. F. Halstead (*Beyer, Peacock & Co., Ltd.*); Mr. Bradford Leslie (*A. J. Barry & Leslie*); Mr. Edward Mills (*Williams Foster & Co.*, and *Pascoe, Grenfell & Sons, Ltd.*); **Mr. F. E. Robertson, C.I.E. (*Rendel & Robertson*); Mr. Frederick Toulinson (*Broughton Copper Co., Ltd.*); Mr. Seymour B. Tritton (*Rendel & Robertson*); Mr. J. N. Vickers (*Vickers, Ltd.*); Mr. Robert White (*Sir George Bruce & White*).

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* Succeeded Major T. H. Cochrane, M.V.O., R.E., October, 1909.

† Succeeded Mr. J. F. Robinson, January, 1910.

‡ Succeeded Mr. James Holden, June, 1908.

§ Succeeded Mr. F. W. Dick, July, 1909.

‖ Succeeded Mr. John Carruthers, July, 1910.

¶ Succeeded Mr. A. S. Jameson, June, 1911.

** Deceased.

SECTIONAL COMMITTEE ON RAILWAY ROLLING STOCK UNDERFRAMES.

December, 1911.

Chairman, SIR DOUGLAS FOX.

Crown Agents for the Colonies: Mr. G. L. Eyles, C.M.G.; Mr. Ashton M. Heath.

Mr. D. Bain (*Midland Railway*); Mr. Lincoln Chandler (*Metropolitan Amalgamated Railway Carriage and Wagon Co., Ltd.*); Mr. Thomas G. Clayton (*late Midland Railway*); Mr. Brodie Henderson (*Livesey, Son & Henderson*); †Mr. G. A. Hobson (*Sir Douglas Fox & Partners*); *Mr. H. D. Earl (*London & North Western Railway*); †Mr. F. E. Robertson, C.I.E. (*Rendel & Robertson*); Mr. H. J. Skelton (*H. J. Skelton & Co.*).

* Succeeded Mr. C. A. Park, June, 1910.

†. Deceased.

LOCOMOTIVE SUB-COMMITTEES.

December, 1911.

SUB-COMMITTEE ON TYRES, AXLES AND SPRINGS.

Chairman, Mr. G. J. Churchward.

†Mr. H. C. Arbuthnott; Mr. W. J. Armitage; Mr. D. Bain; Mr. Lincoln Chandler; Mr. F. C. Fairholme; Mr. Albert Good; Mr. Richard Halstead; Mr. Ashton M. Heath; Mr. C. Hitchcock; Mr. Henry Steel, Jnr.; Dr. W. C. Unwin.

SUB-COMMITTEE ON LOCOMOTIVE STEEL PLATES.

Chairman, Mr. W. Lorimer.

Mr. G. Ainsworth; Mr. D. Cassels; Mr. Maxmilian Mannaberg; †Mr T. P. Reay; Dr. W. C. Unwin.

SUB-COMMITTEE ON COPPER AND ITS ALLOYS.

Chairman, Mr. J. F. McIntosh, M.V.O.

Mr. J. Hartley Bibby; Mr. Edward Mills; Mr. Hugh Reid; Mr. Frederick Tomlinson.

† Deceased.

PREFACE TO FIRST EDITION.

The subject of the Standardisation of Locomotives was first raised at a meeting of the Main Committee on January 14th, 1902, when Sir John Wolfe Barry recorded interviews he had had with Lord George Hamilton and other officials of the India Office with regard to this subject, and it was agreed that evidence should be collected. On March 4th, 1902, the Main Committee sat to hear evidence on the subject, and this being in favour of proceeding, a Sectional Committee on Locomotives was formed under the Chairmanship of Sir Douglas Fox.

The Sectional Committee on Locomotives held their first meeting on May 30th, 1902, when the following Sub-Committees were formed :—

Name.	*Chairman.*
Locomotive Steel Plates .	Mr. W. LORIMER.
Tyres, Axles, and Springs	Mr. W. LORIMER.
Copper and its Alloys .	Mr. W. DEAN. (Succeeded by Mr. J. F. McINTOSH.)

A number of meetings of the Sub-Committees have been held, and the Report in its present form was adopted by the Sectional Committee on Locomotives at their meeting held on March 23rd, 1906.

The Sectional Committee on Locomotives desire to place on record their appreciation of the services rendered by the Association of Railway Locomotive Engineers through their representatives on the Committee.

In many instances somewhat divergent opinions have had to be reconciled, and this has only been rendered possible by accepting the view that the Standard Specifications will be considered from time to time as occasion requires, and the Sectional Committee are desirous of making this point clear when submitting their Report.

To meet the various needs of the Home, Indian, and Colonial requirements, the Committee have in many cases included similar Specifications—one with, and the other without, a Chemical Analysis —in order that those who do not desire to specify a Chemical Analysis can still use a Standard Specification.

The Sectional Committee on Railway Rolling Stock Underframes, under the same Chairman, was appointed by the Main Committee at their meeting on July 16th, 1901. Having, in conjunction with the Sectional Committee on Sections used in Shipbuilding and that on Bridges and General Building Construction, completed the drawing up of a list of Standard Sections, the preparation of a Standard Specification was proceeded with. For convenience of publishing, this Specification is included in the present volume, and constitutes Specification No. 17.*

The Specifications were considered by the Sectional Committee on Underframes at a meeting held in conjunction with the Sectional Committee on Locomotives on March 23rd, 1906, and finally adopted by the Sectional Committee on Locomotives at their meeting held on July 12th, 1906.

The Reports of the two Sectional Committees, which are contained in the present volume, were approved by the Main Committee at the meeting held on July 26th, 1906.

DOUGLAS FOX,

Chairman of the Sectional Committees on Locomotives and Railway Rolling Stock Underframes.

PREFACE TO SECOND EDITION.

Since the issue of the first revision in June, 1907, the Committees on Locomotives and Railway Rolling Stock Underframes have from time to time had brought before them points which have arisen in connection with the use of the Standard Specifications, and the present issue of Report No. 24 embodies the Committee's decisions in regard to these. Some of the more important modifications to the Specifications are as follows :—

1. The prohibition of a re-test in the case of failure under the falling weight test for Axles.

2. The option of a bend test in the Specification for Carriage and Wagon Axles (without analysis) if there is any question in the mind of the Engineer as to the Axle having satisfactorily passed the falling weight test.

3. The deletion of the Specification (without analysis) for Locomotive Tyres.

4. The deletion of Class **B** tyres (42-48 tons per square inch) from the Specification (with Analysis) for Locomotive Tyres.

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* Now published in Part VI. of Report No. 24—1911.

5. The addition of Class **C** tyres (50-55 tons per square inch) to the Specification (without Analysis) for Carriage and Wagon Tyres.

6. The deletion of Class **A** tyres (35-40 tons per square inch) from the Specification (without Analysis) for Carriage and Wagon Tyres.

7. The insertion in the Tyre Specifications of a formula for the deflection under the falling weight test based upon the thickness and internal diameter of the tyre in place of that previously employed which was based upon the internal diameter only.

8. The division of the Specifications for Laminated Springs and Spring Steel into separate Specifications, dealing respectively with Spring Steel and with the finished Springs.

With a view of restricting the tensile stress on the plates of the finished Spring under the scragging test to a figure somewhat below 70 tons per square inch, a definite deflection, depending upon the length of the top plate of the Spring and thickness of the thickest plate, is now specified, and a table of the required deflections is inserted in the Specification.

9. The addition of a further class of Forgings (Class **E**) to the Forging Specification.

10. The reduction of the tensile strength of Rivet Bars to 24-28 tons per square inch.

The Committee have had representations made to them with regard to the use of the term "*Elastic Limit*" in the Axle and Forging Specifications, and this term has now been altered to "*Yield Point*," a definition of this latter term being added as a note to the Specifications in which this term is employed.

The Committee recommend that in specifying materials to any of the Specifications contained in this Report, both the Specification number and the number of the Report be quoted, in order to obviate confusion with other Reports of the Committee.

The Report in its present form was approved by the Sectional Committees concerned in October, 1911, and by the Main Committee on December 6th, 1911.

DOUGLAS FOX,

Chairman of the Sectional Committee on Locomotive and Railway Rolling Stock Underframes.

Reference to be quoted.

Report No. 24
Specification No. 11-1911

Note.—*The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to include all the necessary provisions of a Contract.*

BRITISH STANDARD SPECIFICATION FOR COPPER PLATES FOR LOCOMOTIVE FIRE BOXES.

(REVISED DECEMBER, 1911.)

Chemical Analysis.

1. The Plates shall be of one of two classes, to meet the largely varying chemical constituents of coal and differing conditions of use, and must comply with the requirements specified below :—

Class **A.**—The Plates must contain not less than 99 per cent. of Copper, and 0·35 per cent. to 0·55 per cent. must consist of Arsenic.

Class **B.**—The Plates must contain not less than 99·25 per cent. of Copper, and 0·25 per cent. to 0·45 per cent. must consist of Arsenic.

The Manufacturer shall supply an analysis when required to do so.

Freedom from Defects.

2. The Plates must be clean, smooth, and free from surface defects.

Branding.

3. Each Plate shall be stamped with the Manufacturer's name and plate number, at about 12 inches from the end in the centre line of the Plate, and shall also be distinctly stamped with such marks of identification as the Engineer (or the Purchaser) may require.

Mechanical Tests.

4. The scrap margin before shearing shall be not less than 3 inches at each end, and 1½ inches at each side of the Plate; from this margin a piece 2 inches wide shall be left attached to the Plate at each end, from which the representative of the Engineer (or of the Purchaser) will mark lengths for tensile and

bend tests. All test pieces shall be in the same condition as when severed from the Plate and must withstand the following tests :—

Tensile Test.

5. A Standard Test Piece **A,** having a gauge length of 8 inches (*see* Appendix, page 24), must show a tensile breaking strength of not less than 14 tons per square inch, with an elongation of not less than 35 per cent.

Bend Test.

6. Pieces of the Plate shall be tested both cold and at a red heat by being doubled over on themselves—that is, bent through an angle of 180 degrees, without showing either crack or flaw on the outside of the bend.

Inspection.

7. The representative of the Engineer (or of the Purchaser) shall be at liberty to reject any material that does not conform to the terms of this Specification. He will attend to stamp pieces for tests before delivery, and no Plate will be accepted which will not stand the specified tests, or which, upon analysis, is found to exceed the limits stated for the chemical composition.

Testing Facilities.

8. The Manufacturer shall supply the material required for testing free of charge and shall, at his own cost, furnish and prepare the necessary test pieces, and supply labour and appliances for such testing as may be carried out on his premises in accordance with this Specification. Failing facilities at his own works for making the prescribed tests, the Manufacturer shall bear the cost of carrying out the tests elsewhere.

Reference to be quoted.

Report No. 24
Specification No. 12-1911

Note.—*The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to include all the necessary provisions of a Contract.*

BRITISH
STANDARD SPECIFICATION
FOR
COPPER RODS
FOR
LOCOMOTIVE STAY BOLTS, RIVETS, ETC.

(REVISED DECEMBER, 1911.)

Chemical Analysis.

1. The Rods must contain not less than 99·25 per cent. of Copper, and 0·15 per cent. to 0·35 per cent. must consist of Arsenic.

The Manufacturer shall supply an analysis when required to do so.

Freedom from Defects.

2. The Rods must be clean, smooth, uniform in diameter, and free from surface defects.

Branding.

3. Each Rod shall be stamped with the Manufacturer's name near one end.

Mechanical Tests.

4. The representative of the Engineer (or of the Purchaser) shall select and test, up to two per cent. of each diameter of Rods ordered under the contract, such of the Rods as he may think proper. All test pieces shall be in the same condition as when severed from the Rods, and must comply with the following tests :—

Tensile Test.

5. The tensile strength must be not less than 14 tons per square inch, with an elongation of not less than 40 per cent. on Standard Test Piece **B,** having a gauge length of not less than 8 times the diameter (*see* Appendix, page 25) When a very small test piece is required, Standard Test Piece **D,** having a gauge length of 3 inches (*see* Appendix, page 25) shall be used, in which case the elongation must be not less than 45 per cent.

Reference to be quoted.

Report No. 24
Specification No. 12-1911

Hammering or Crushing Down Test.

6. A piece of Rod 1 inch long shall be placed on end and hammered or crushed down to a thickness of $\frac{3}{4}$ inch, without showing either crack or flaw on the circumference of the resulting disc.

Inspection.

7. The representative of the Engineer (or of the Purchaser) shall be at liberty to reject any material that does not conform to the terms of this Specification. He will attend to stamp pieces for tests before delivery, and no Rod will be accepted which will not stand the specified tests, or which, upon analysis, is found to exceed the limits stated for the chemical composition.

Testing Facilities.

8. The Manufacturer shall supply the material required for testing free of charge and shall, at his own cost, furnish and prepare the necessary test pieces, and supply labour and appliances for such testing as may be carried out on his premises in accordance with this Specification. Failing facilities at his own works for making the prescribed tests, the Manufacturer shall bear the cost of carrying out the tests elsewhere.

Reference to be quoted.

Report No. 24
Specification No. 13-1911

Note.—*The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to include all the necessary provisions of a Contract.*

BRITISH STANDARD SPECIFICATION FOR COPPER TUBES FOR LOCOMOTIVE BOILERS.

(REVISED DECEMBER, 1911.)

Chemical Analysis.

1. The Tubes must contain not less than 99 per cent. of Copper, and 0·35 per cent. to 0·55 per cent. must consist of Arsenic.

The Manufacturer shall supply an analysis when required to do so.

Freedom from Defects.

2. The Tubes must be clean, smooth and free from surface defects or longitudinal grooving, internally and externally, and the ends must be clean and square. They must be of the dimensions and weight specified, straight, cylindrical, and of uniform thickness, and, unless otherwise specified, of uniform diameter throughout.

Branding.

3. Each Tube shall be stamped on the outside with the Manufacturer's name.

Mechanical Tests.

4. The Manufacturer shall provide, at his own expense, extra Tubes at the rate of one per cent. of each diameter of Tube ordered under the contract, and the representative of the Engineer (or of the Purchaser) shall select and test such of the Tubes as he may think proper to the extent of such percentage. All test pieces shall be annealed before testing, and must comply with the following mechanical tests without further annealing :—

Bulging or Drifting Test.

5. The Tubes must stand bulging or drifting, without showing either crack or flaw, until the diameter of the bulged or drifted end measures not less than 25 per cent. greater than the original diameter of the Tube.

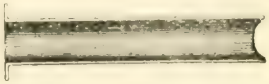
Bulging Test.

Drifting Test.

Reference to be quoted.
Report No. 24
Specification No. 13-1911

Flanging Test.

6. The Tubes must stand flanging, without showing either crack or flaw, until the diameter of the flange measures not less than 40 per cent. greater than the original diameter of the Tube.



Flattening and Doubling-over Test.

7. The Tubes must be capable of standing the following test, both cold and at a red heat, without showing either crack or flaw. A piece of the Tube shall be flattened down until the interior surfaces of the Tube meet, and then be doubled over on itself, that is, bent through an angle of 180 degrees, the bend being at right angles to the direction of the length of the Tube.

Hydraulic Test.

8. All Copper Boiler Tubes shall be tested by an internal hydraulic pressure of at least 750 lbs. per square inch.

Inspection.

9. The representative of the Engineer (or of the Purchaser) shall be at liberty to reject any material that does not conform to the terms of this Specification. He will attend to stamp pieces for tests before delivery, and no Tube will be accepted which will not stand the specified tests, or which, upon analysis, is found to exceed the limits stated for the chemical composition.

Testing Facilities.

10. The Manufacturer shall supply the material required for testing free of charge and shall, at his own cost, furnish and prepare the necessary test pieces, and supply labour and appliances for such testing as may be carried out on his premises in accordance with this Specification. Failing facilities at his own works for making the prescribed tests, the Manufacturer shall bear the cost of carrying out the tests elsewhere.

Reference to be quoted.

Report No. 24
Specification No. 14-1911

Note.—*The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to include all the necessary provisions of a Contract.*

BRITISH STANDARD SPECIFICATION FOR BRASS TUBES FOR LOCOMOTIVE BOILERS.

(REVISED DECEMBER, 1911.)

Composition.

1. Brass for Locomotive Boiler Tubes may be of either 70/30 alloy or 2/1 alloy as specified.

Chemical Analysis.

2. The Tubes must consist of an alloy of Copper and Zinc, and must contain :—

70/30 Alloy.—Not less than 70 per cent. of metallic Copper and not more than a total of 0·75 per cent. of materials other than Copper and Zinc.

2/1 Alloy.—Not less than 66·7 per cent. of metallic Copper and not more than a total of 0·75 per cent. of materials other than Copper and Zinc.

The Manufacturer shall supply an analysis when required to do so.

Freedom from Defects.

3. The Tubes must be clean, smooth, and free from surface defects or longitudinal grooving, internally and externally, and the ends must be clean and square. They must be of the dimensions and weight specified, straight, cylindrical, and of uniform thickness, and, unless otherwise specified, of uniform diameter throughout.

Annealing.

4. The Tubes shall be carefully annealed at both ends.

Branding.

5. Each Tube shall be stamped on the outside with the Manufacturer's name.

Reference to be quoted.
Report No. 24
Specification No. 14-1911

Mechanical Tests.

6. The Manufacturer shall provide, at his own expense, extra Tubes at the rate of one per cent. of each diameter of Tube ordered under the contract, and the representative of the Engineer (or of the Purchaser) shall select and test such of the Tubes as he may think proper to the extent of such percentage. All test pieces shall be annealed before testing and must comply with the following mechanical tests without further annealing :—

Bulging or Drifting Test.

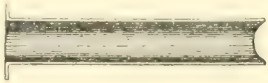
7. The Tubes must stand bulging or drifting, without showing either crack or flaw, until the diameter of the bulged or drifted end measures not less than 25 per cent. greater than the original diameter of the Tube.

Bulging Test.

Drifting Test.

Flanging Test.

8. The Tubes must stand flanging, without showing either crack or flaw, until the diameter of the flange measures not less than 25 per cent. greater than the original diameter of the Tube.



Flattening and Doubling-over Test.

9. The Tubes must be capable of standing the following test, when cold, without showing either crack or flaw. A piece of the Tube shall be flattened down until the interior surfaces of the Tube meet, and then be doubled over on itself, that is, bent through an angle of 180 degrees, the bend being at right angles to the direction of the length of the Tube.

Hydraulic Test.

10. All Brass Boiler Tubes shall be tested by an internal hydraulic pressure of at least 750 lbs. per square inch.

Inspection.

11. The representative of the Engineer (or of the Purchaser) shall be at liberty to reject any material that does not conform to the terms of this Specification. He will attend to stamp pieces for tests before delivery, and no Tube will be accepted which will not stand the specified tests, or which, upon analysis, is found to exceed the limits stated for the chemical composition.

Testing Facilities.

12. The Manufacturer shall supply the material required for testing free of charge and shall, at his own cost, furnish and prepare the necessary test pieces, and supply labour and appliances for such testing as may be carried out on his premises in accordance with this Specification. Failing facilities at his own works for making the prescribed tests, the Manufacturer shall bear the cost of carrying out the tests elsewhere.

Reference to be quoted.

Report No. 24
Specification No. 15-1911

Note.—*The Association desires to call attention to the fact that this Specification is intended to include the technical provisions necessary for the supply of the material herein referred to, but does not purport to include all the necessary provisions of a Contract.*

BRITISH
STANDARD SPECIFICATION
FOR
SEAMLESS COPPER TUBES
FOR
LOCOMOTIVE FEED PIPES, ETC.

(REVISED DECEMBER, 1911.)

Chemical Analysis.

1. The Tubes must contain not less than 99·25 per cent. of Copper, and 0·25 per cent. to 0·45 per cent. must consist of Arsenic.

The Manufacturer shall supply an analysis when required to do so.

Freedom from Defects.

2. The Tubes must be clean, smooth, and free from surface defects or longitudinal grooving, internally and externally, and the ends must be clean and square. They must be of the dimensions and weight specified, straight, cylindrical and of uniform thickness, and unless otherwise specified, of uniform diameter throughout.

Branding.

3. Each Tube shall be stamped on the outside with the Manufacturer's name.

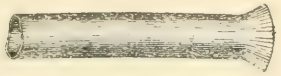
Mechanical Tests.

4. The Manufacturer shall provide, at his own expense, extra Tubes at the rate of one per cent. of each diameter of Tube ordered under the contract, and the representative of the Engineer (or of the Purchaser) shall select and test such of the Tubes as he may think proper to the extent of such percentage. All test pieces shall be annealed before testing and must comply with the following mechanical tests without further annealing: —

Drifting Test.

5 The Tubes must stand drifting, without showing either

crack or flaw, until the diameter of the drifted end measures at least 25 per cent. greater than the original diameter of the Tube.



Flattening and Doubling-over Test.

6. The Tubes must be capable of standing the following test, both cold and at a red heat, without showing either crack or flaw. A piece of the Tube shall be flattened down until the interior surfaces of the Tube meet, and then be doubled over on itself, that is, bent through an angle of 180 degrees, the bend being at right angles to the direction of the length of the Tube.

Hydraulic Test.

7. All Seamless Copper Tubes shall be tested by such internal hydraulic pressure as may be specified by the Engineer (or by the Purchaser).

Inspection.

8. The representative of the Engineer (or of the Purchaser) shall be at liberty to reject any material that does not conform to the terms of this Specification. He will attend to stamp pieces for tests before delivery, and no Tube will be accepted which will not stand the specified tests, or which, upon analysis, is found to exceed the limits stated for the chemical composition.

Testing Facilities.

9. The Manufacturer shall supply the material required for testing free of charge and shall, at his own cost, furnish and prepare the necessary test pieces, and supply labour and appliances for such testing as may be carried out on his premises in accordance with this Specification. Failing facilities at his own works for making the prescribed tests, the Manufacturer shall bear the cost of carrying out the tests elsewhere.

Conversion Table.

Tons.	Pounds.	Tons.	Pounds.
17	38,080	44	98,560
18	40,320	45	100,800
19	42,560	46	103,040
20	44,800	47	105,280
21	47,040	48	107,520
22	49,280	49	109,760
23	51,520	50	112,000
24	53,760	51	114,240
25	56,000	52	116,480
26	58,240	53	118,720
27	60,480	54	120,960
28	62,720	55	123,200
29	64,960	56	125,440
30	67,200	57	127,680
31	69,440	58	129,920
32	71,680	59	132,160
33	73,920	60	134,400
34	76,160	61	136,640
35	78,400	62	138,880
36	80,640	63	141,120
37	82,880	64	143,360
38	85,120	65	145,600
39	87,360	66	147,840
40	89,600	67	150,080
41	91,840	68	152,320
42	94,080	69	154,560
43	96,320	70	156,800

NOTE.—1 Ton = 2,240 lbs.

APPENDIX.

FORMS

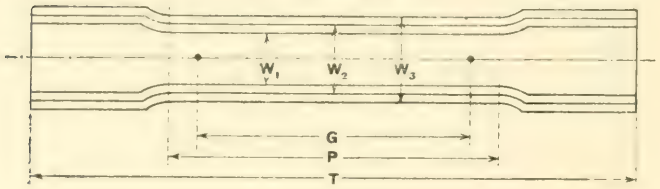
OF

BRITISH STANDARD TENSILE TEST PIECES

APPENDIX.

FORMS
OF
BRITISH STANDARD TENSILE TEST PIECES.

TEST PIECE **A.**

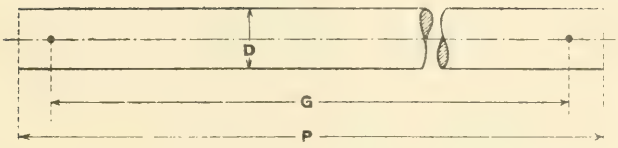


Gauge Length **G** = 8 inches.
Parallel Length **P** to be not less than 9 inches
Total Length **T** = about 18 inches.

Thickness of Test Piece.	Maximum Width allowed.
Over $\frac{7}{8}$ in. (0·875 in.).	W_1 = $1\frac{1}{2}$ ins.
$\frac{3}{8}$ in. (0·375 in.) to $\frac{7}{8}$ in. (0·875 in.).	W_2 = 2 ins.
Under $\frac{3}{8}$ in. (0·375 in.).	W_3 = $2\frac{1}{2}$ ins.

The widths of the test pieces for plates were selected to comply with the two following conditions. (1) As the great bulk of plates to be tested are from $\frac{3}{8}$ inch to $\frac{7}{8}$ inch thick, it was desirable for the sake of convenience that the test pieces for such plates should be of uniform width, and, in accordance with very general practice, a width of 2 inches was selected. (2) With a test piece of a given form, the percentage of elongation was found to be less for thick plates than for thin ones; with steel of the same quality in other respects it was desirable therefore to choose widths of test piece which would be slightly in favour of the thicker plates. This is secured with the widths selected for the Standard Test piece of form **A.**

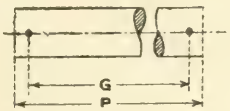
TEST PIECE **B.**



Gauge Length **G** to be not less than 8 times the diameter **D**.
With enlarged ends :—Parallel Length **P** to be not less than 9 times the reduced diameter **D**.

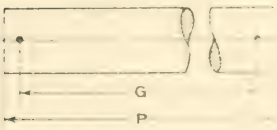
All test pieces of form **B** are strictly similar, and for the same material give the same percentage of elongation. They are nearly similar to a test piece of form **A**, 8 inches in gauge length, 2 inches wide and $\frac{3}{8}$ inch thick.

TEST PIECE **C.**



Gauge Length **G** = 2 inches.
Parallel Length **P** to be not less than $2\frac{1}{4}$ inches.
Dia. = 0·564 inch.
Area = $\frac{1}{4}$ sq. inch.

TEST PIECE **D.**



Gauge Length **G** = 3 inches.
Parallel Length **P** to be not less than $3\frac{3}{8}$ inches.
Dia. = 0·798 inch.
Area = $\frac{1}{2}$ sq. inch.

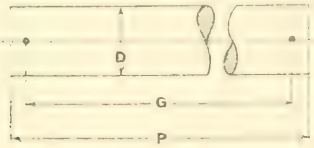
TEST PIECE **E.**

Gauge Length **G** = $3\frac{1}{2}$ inches.
Parallel Length **P** to be not less than 4 inches.
Dia. = 0·977 inch.
Area = $\frac{3}{4}$ sq. inch.

Test pieces **C, D** and **E** were arranged to meet the very common practice of making test pieces for forgings, axles, tyres, etc., of either $\frac{1}{4}$ square inch or $\frac{1}{2}$ square inch in sectional area. With the gauge lengths decided upon, these three forms are very nearly similar, and, for a given material, give very approximately the same percentage of elongation. Though not exactly, they are approximately similar to the Standard Test Piece **F,** and for the same material give a nearly identical, but slightly greater, percentage of elongation.

TEST PIECE **F.**

(For Test Pieces over 1 inch diameter.)



Gauge Length **G** to be not less than 4 times the diameter **D**.
With enlarged ends:—Parallel Length **P** to be not less than $4\frac{1}{2}$ times the reduced diameter **D**.

In some testing machines it was found inconvenient to use form **B** for bars of over 1 inch in diameter, and form **F** of half the gauge length is designed to meet such cases. For a given material the percentage of elongation with Test Piece **F** is greater than with Test Piece **B,** and this difference is provided for in the British Standard Specifications.

FORM OF ENDS

In the case of the round test pieces **B, C, D, E** and **F,** the form of the ends is to be as required in order to suit the various methods employed for gripping the test piece. When enlarged ends are used the length of the parallel portion of the test piece must in no case be less than that noted on the diagrams.

British Engineering Standards Association.

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OF

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NOVEMBER, 1919.

(This List cancels all previous Lists.)

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